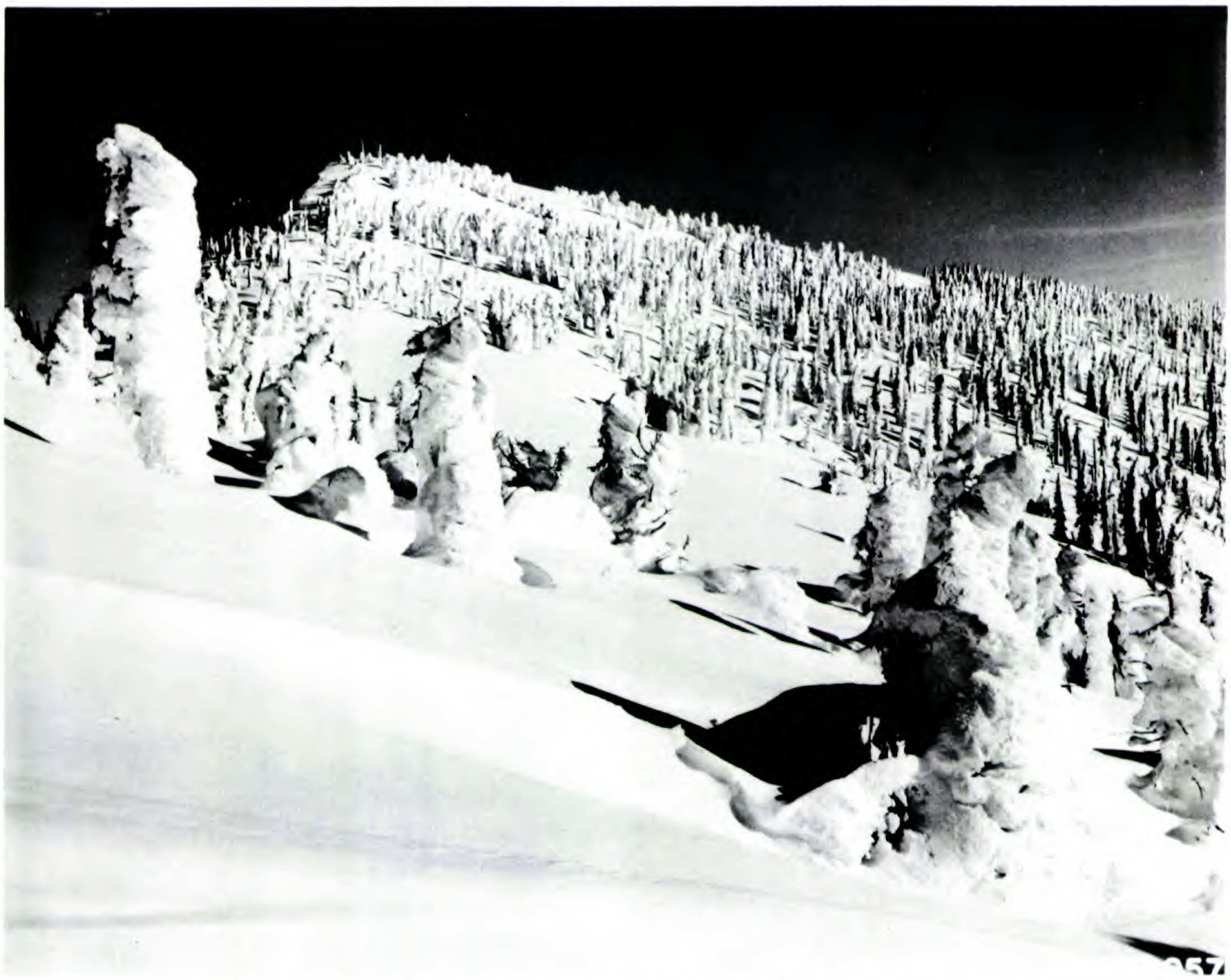

FIGURE 16. "Snow ghost" forest in the subalpine zone of northern Idaho's Bald Mountain (2,300 m). Snow-caked trees are *Abies lasiocarpa*. USDA Forest Service.

richer than in any of the other subunits. It includes *Clintonia uniflora, Adenocaulon bicolor, Disporum hookeri, Tiarella trifoliata, Cornus canadensis, Aralia nudicaulis, Rubus parviflorus, Athyrium filix-femina, Gymnocarpium dryopteris, Menziesia ferruginea, Taxus brevifolia, Oplopanax horridum, Pachistima myrsinites,* and many other species.

A limited amount of the arid *Pinus ponderosa/Festuca idahoensis/Agropyron spicatum* habitat type also occurs within intermontane valleys running through the Inland Maritime region. For example, a steep precipitation-vegetation gradient exists, west to east, between Spokane, Washington (38 cm/yr., pine-grassland savanna) and nearby (40 km east) Coeur d'Alene, Idaho (75 cm/yr., cedar–hemlock–western white pine forests).

Fires occur at lower frequencies (100-year intervals or longer) in this geographic region (Habeck, 1985). When wildfires do occur, however, they are often of much higher intensity ("stand replacement" fires), due to the greater organic matter ("fuel") accumulations in these moist forests. When the right combination of midsummer "fire weather" occurs—characterized by high temperatures, gusty afternoon winds, dry ground fuels, low humidity, and lightning—the Inland Maritime forests may have wildfires capable of removing all aboveground plant cover (Habeck & Mutch, 1973). *Larix occidentalis, Pinus contorta,* and/or *Pinus monticola* are important postfire species, but it is not uncommon for the potential climax species to make an initial entry at the same time. Examples of short interval (less than 10 years) "double" and "triple" burns exist, and forest recovery on such sites may be retarded for many decades.

Deep snow accumulations in the Inland Maritime mountains (Fig. 17) cause frequent avalanches. In minutes, tons of flowing snow and fierce winds may smash and mangle the vegetation in the snow track. Snow slide chutes are often dominated by such woody angiosperms as

FIGURE 17. Snow cornice above *Picea engelmannii* and *Abies lasiocarpa* forest at 2,100 m in Panhandle National Forest, northern Idaho. USDA Forest Service.

Alnus sinuata, Amelanchier alnifolia, Sorbus spp., *Acer glabrum, Populus trichocarpa, P. tremuloides, Salix* spp., and a rich assortment of perennial herbs that seem well adapted to frequent avalanches.

VEGETATION OF THE SOUTHERN CANADIAN ROCKIES

The southern Canadian Rockies are composed of high, rugged terrain with a long history of glaciation. The mountain ranges often reach or exceed 2,400 m, with peaks over 3,000 m. The southern Canadian Rockies embrace several major mountain ranges near the United States/Canada border, including the Selkirk, Purcell, and Monashee mountains, the Continental Divide itself ("The Great Divide") separating Alberta from British Columbia, and several front ranges east of the Great Divide (Fig. 4, Region E).

Frigid polar air masses characterize the continental climate east of the Great Divide in Alberta. The dessicating winter winds are similar to those described for the east front of the Montana Rockies; these winds are responsible for "red belt" mortality among the conifer communities located here. Just west of the Great Divide, the climate is more like that of the Inland Maritime

region in northern Idaho and northwestern Montana; mild and wet weather prevails as Pacific coastal storm tracks penetrate eastward (Arno & Hammerly, 1984).

Southeastern British Columbia, parts of which lie in the Cascade Mountains rainshadow, has a warm and dry lower timberline in valley bottoms where only 25–40 cm of precipitation occurs annually. Open *Pinus ponderosa* woodlands, bunchgrass prairies (*Agropyron spicatum* and *Festuca idahoensis*), and sagebrush steppe (*Artemisia tridentata*) form the major plant communities in the semiarid valleys (Tisdale & McLean, 1957; McLean, 1970; Tisdale, 1974). Some of the upper slopes of nearby mountains also have low annual precipitation, and at mid-elevation slopes a forest zone dominated by *Pseudotsuga menziesii* occurs. Above this is the subalpine zone dominated by *Abies lasiocarpa, Picea engelmannii,* and *Pinus albicaulis,* which ultimately form a krummholz on upper slopes above 2,100 m. Past fires in southeastern British Columbia perpetuated extensive stands of *Pinus contorta* at middle and upper elevations (LaRoi & Hnatiuk, 1980; Arno & Hammerly, 1984).

Those parts of southeastern British Columbia that receive greater coastal moisture display forest vegetation similar to that of the Inland Maritime region in the United States. Warm, dry, lower timberlines occur only rarely in this part of the Canadian Rockies, where dominants include *Thuja plicata, Tsuga heterophylla, Abies grandis, Pseudotsuga menziesii, Picea engelmannii,* and *P. engelmannii* × *P. glauca* hybrids. *Pinus contorta, Abies lasiocarpa, Tsuga mertensiana, Pinus albicaulis,* and *Larix lyallii* are the major timberline dominants in the Selkirk and Purcell mountains. Timberline in these ranges typically occurs at elevations below 2,100 m; however, it may occur below 1,500 m in areas of deep snow accumulations. The highest mountain peaks (over 3,000 m) support permanent snowfields and glaciers (Shaw, 1916).

The Alberta Rockies consist of the mountains forming the Great Divide. From Waterton Park northward to Banff and Jasper National Parks, the Divide peaks reach from 2,800 m to nearly 3,650 m in height. The continental climate in Alberta disfavors the occurrence of tree species adapted to milder maritime conditions. Annual precipitation is near 150 cm at the higher elevations but less than 50 cm on the east front at Calgary. The subalpine and montane forest zones are dominated by the same species listed above for British Columbia, except that maritime trees like *Thuja* and *Tsuga* are missing. At timberline, *Abies lasiocarpa, Picea engelmannii, Larix lyallii,* and *Pinus albicaulis* form the upper treeline communities, including the krummholz zone (Moss, 1955; Ogilvie, 1963, 1976; Day, 1972; Corns & Achuff, 1982).

The lower forest zones adjoining the grasslands are mixtures of *Pseudotsuga menziesii, Picea glauca* (and hybrids *P. glauca* × *P. engelmannii*), and *Populus tremuloides.* Local moisture-stressed sites support *Pinus flexilis* (Moss, 1944; Rowe, 1959; Stringer & LaRoi, 1970). *Pinus ponderosa* is absent, according to Arno & Hammerly (1984), seemingly unable to tolerate winter desiccation and rapid temperature changes. As was described for other areas of the NRM, frequent high intensity wildfires helped develop and perpetuate extensive stands of *Pinus contorta* throughout much of the Alberta Rockies, from the lower to the upper timberline (Tande, 1979).

The natural grasslands in southern Alberta east of the Great Divide occur where precipitation becomes lower, temperatures are warmer, Chinook winds prevail, and evaporation rates are high (Moss, 1944; Moss & Campbell, 1947). Moss (1944) described three prairie community types: *Bouteloua gracilis/Stipa comata, Agropyron/Stipa/Carex,* and *Festuca scabrella/F. idahoensis/Danthonia intermedia/D. parryi.* Much of the native prairie no longer exists because of modern levels of grazing and mowing.

VEGETATION OF THE MIDDLE ROCKY MOUNTAINS

The last part of the Rocky Mountains to be treated here lies north of Provo and Salt Lake City, Utah, in the vicinity of 40°N, and includes the adjacent parts of northwestern Colorado, the Medicine Bow Mountains in southeastern Wyoming, the remainder of Wyoming west and north of the Wyoming Basin desert, north to south-central Montana (Beartooth Plateau), and west to the Snake River Plain in southern Idaho (Fig. 4, Region F). This region coincides with the "Middle Rockies" as discussed by Oosting & Reed (1952), Johnson & Pfister (1982), Arno & Hammerly (1984), and Mutel & Emerick (1984), and includes the northeastern part of the Rockies that Reveal (1979) designated "the Intermountain Region." Figure 6 shows the typical vegetation zones in this part of the Rocky Mountains.

The Utah portions of the middle Rocky Moun-

tains support a flora that contains many elements that are geographically centered further to the south and southwest, characteristic of the pinyon-juniper, chaparral, and Great Basin desert vegetation types. In contrast, western Wyoming ranges are without these floristic inclusions and display more elements common to the East Front of the Rockies in central Montana (Arno & Hammerly, 1984). The forest vegetation of this region is usually dependent on melting of deep winter snow packs (from Pacific storms) to supply needed summer moisture. The inland continental climate lacks a maritime component of the sort described earlier (Baker, 1944).

Arno & Hammerly (1984) described the middle Rockies as an area of well-separated ranges diverse in geologic structure and rock types. Johnson & Pfister (1982) provided detailed interpretive summaries of the geology of this region. Three geologic mountain types exist (see Fig. 4 for locations): 1) anticlinal mountains (Beartooth Plateau, Big Horn–Pryor Mountains, Uinta Mountains, and Wind River Range); 2) mountains of the overthrust belt (Tetons, Wyoming, and Wasatch ranges); and 3) volcanic mountains (Yellowstone Plateau and Absaroka Range). The highest points in the middle Rocky Mountains reach up to approximately 4,200 m (Gannett Peak and Grand Teton), although more typical heights range between 3,000 and 3,600 m.

The Wasatch and Uinta ranges have broken patches and stringers of timber on their upper mountain slopes, a result of frequent avalanches clearing wide tracks through the timber. Several tree species achieve dominance here, including *Pseudotsuga menziesii, Pinus flexilis, Picea pungens, Abies concolor,* and *Populus tremuloides. Pinus contorta* is present in the northern part of the Wasatch Range but *Pinus ponderosa* is scarce. The lower Wasatch slopes are covered with *Quercus gambelii, Cercocarpus ledifolius,* and *Acer grandidentatum.* This mountain shrub or chaparral type replaces the pinyon-juniper vegetation zone found further westward in Nevada (Hayward, 1945, 1948; Arno & Hammerly, 1984).

The Uinta Mountains, which have an east–west orientation, are capped with an extensive alpine zone above 3,300 m (Hayward, 1952). Below this and forming the krummholz and upper subalpine zones are stands of *Picea engelmannii, Abies lasiocarpa,* and *Pinus flexilis*; this region is beyond the distribution of *Pinus albicaulis.* Extending down to 2,700 m below these zones are *Pinus contorta* forests. A wide band of *Populus tremuloides,* serving as a major seral species in the middle Rockies, occurs below the *Pinus contorta* zone. *Pinus ponderosa* is scattered on south slopes and found more extensively on north ones at the lower Uinta timberline down to 2,100 m. Mid elevations support extensive stands of *Pseudotsuga menziesii*; moist drainages (riparian sites) contain *Picea pungens* communities.

Arno & Hammerly (1984) and Ellison (1954) provided additional descriptions of the contrasting climatic and vegetational features between the Wasatch and nearby Uinta ranges. In contrast to the Wasatch Range, the Uintas lack the oak-maple chaparral but support a pinyon-juniper type. In both areas, the lowest and driest shrub zones are dominated by a dozen different species and varieties of sagebrush (*Artemisia* spp.) and *Atriplex canescens, A. confertifolia,* and *Cercocarpus ledifolius.* Variations in summer rainfall, geologic and topographic features, and contracting patterns of past plant migrations have all contributed to these differences.

The modern forest vegetation occurring in Colorado's Front Range (Fig. 4, vicinity of Rocky Mountain National Park) has been the subject of many studies dating back 80 or more years. The most recent and comprehensive among these is the detailed treatment provided by Peet (1981), who reviewed much of the previous vegetation literature for this part of the middle Rocky Mountains. Employing modified gradient analysis techniques, he derived a classification of the Front Range vegetation that accommodated both developmental (successional) and mature (late seral/climax) community types, relating them to a moisture-elevational complex. Peet classified the Front Range vegetation (1981, his fig. 5) into community series as follows: A. *Pinus ponderosa* woodland series; B. *Pinus ponderosa/Pseudotsuga menziesii* forest series; C. Mesic montane forest series (a heterogeneous group that includes *Picea, Abies, Pseudotsuga, Populus, Betula,* and *alnus*); D. *Pinus contorta* forest series; E. *Picea/Abies* forest series; F. *Pinus flexilis* forest series; G. Alpine transition (krummholz) series. His classification also delimits community type subunits within these series. Subsequently, Greenland et al. (1985) described a methodology for defining bioclimatic zones in the Colorado Front Range utilizing a one-dimensional version of Peet's vegetation ordination model.

The importance of 19th century anthropogenic

disturbances within the montane forests of the Front Range have been investigated by Veblen & Lorenz (1986). Patterns of forest recovery following severe logging and burning disturbances inflicted during the Colorado mining booms were studied. Their findings clarify the successional pathways that forest recovery has followed during the last century in this part of the Rocky Mountains.

The upper-elevation forests in a representative watershed within the Medicine Bow Mountains in central Wyoming were discussed in detail by Romme & Knight (1981), who investigated and modeled the interactions of fire frequency and topographic position on vegetation dynamics in this part of the middle Rockies. Although much of the high country in the Medicine Bows has a potential for supporting climax forests dominated by *Picea engelmannii* and *Abies lasiocarpa,* such expressions of spruce-fir forests are primarily confined at this time to moist sites such as ravines and valley bottoms. Past occurrences of short-interval (less than 100 years) wildfires on open slopes and ridgetops favored development and maintenance of *Pinus contorta* forests (Lotan & Perry, 1983). Even though fire suppression has been in operation for more than a century, the slow rates of successional processes in these mountains have tended to impede the return of spruce-fir forests.

Romme & Knight (1981) included within their watershed study area a two-dimensional ordination of all major plant community types occurring between 2,250 and 3,000 m on sites ranging from moist valley bottoms to south slope ridgetops. *Salix, Alnus,* and *Populus* mixtures occur in the lower, moist habitats; *Pseudotsuga menziesii* forests occur on the mesic, lower north slopes; *Artemisia* communities occur on most xeric foothill elevations. At intermediate elevations of 2,500 to 2,700 m, combinations of *Pseudotsuga menziesii, Pinus contorta,* and *Populus tremuloides* prevail. Only moist sites above 2,700 m currently support mature spruce-fir forests.

The mountains in western Wyoming (Wind River, Salt River, and Wyoming ranges, as shown in Fig. 4) support an upper timberline of *Pinus albicaulis,* which achieves notable dominance in this part of the Rockies, and of *Picea engelmannii* and *Abies lasiocarpa* (Loope, 1971; Reed, 1976; Steele et al., 1983; Arno & Hammerly, 1984). A krummholz zone composed of these conifers is found at elevations near 3,050 m throughout these mountains. Much of the subalpine forest zone, however, is dominated by expansive stands of *Pinus contorta* except where limestone substrate prevails. This pine, together with *Pseudotsuga menziesii,* often forms the upper timberline forests at elevations above 2,700 m and then extends downward to the lower zones at or below 2,100 m (Moir, 1969; Arno & Hammerly, 1984). Loope & Gruell (1973) have described the natural role of fire in these northwestern Wyoming forests.

Near the lower timberline, *Populus tremuloides* groves comprise a broken belt separating *Pinus contorta* forests from the sagebrush communities in the lower valleys (Reed, 1971; Youngblood & Mueggler, 1981; Arno & Hammerly, 1984; Fig. 18). Although *Pseudotsuga menziesii* can be found in the western Wyoming mountain ranges, it does not form a distinctive forest zone as it does elsewhere in the northern Rockies, such as in western Montana (Arno, 1979). This is due to the importance of *Pinus contorta* as a seral species in zones where *Pseudotsuga menziesii* is the potential climax dominant. Many of the subalpine conifers can be found at lower timberline, often along mountain stream courses (Arno & Hammerly, 1984). The valleys in the western Wyoming mountain ranges are much cooler than comparable sites elsewhere in the northern Rockies; for this reason, *Populus tremuloides* and mesophytic conifers occupy the lower timberline zone (Steele et al., 1983). Pinyon-juniper and mountain chaparral are missing from the cold western Wyoming mountains (Arno & Hammerly, 1984).

The Absaroka Range and adjacent Beartooth Plateau (Montana–Wyoming border; Fig. 4) display an extensive alpine tundra zone with many ice fields at elevations over 3,000 m. Timberline parkland (open-canopied groves and scattered individuals) is also present, dominated by *Pinus albicaulis, Picea engelmannii,* and *Abies lasiocarpa,* similar to those in the Wind River and Teton ranges.

The Big Horn Mountains, spatially separated from the other middle Rocky Mountain units, are located east of the Big Horn Basin in west-central Wyoming and extend into adjacent parts of Montana (Fig. 4). Elevations in the Big Horns, which occupy an uplifted dome, exceed 4,000 m. Past and present glaciers are prominent landshaping phenomena in this part of the middle Rockies. Annual precipitation is relatively low, reaching about 60 cm in the subalpine forest zone at 2,700 m. Soils derived from granite, shale,

FIGURE 18. Old growth *Populus tremuloides* forest near Scout Lake (3,100 m), Utah. Note conifer invasion in understory. USDA Forest Service.

limestone, and dolomite rocks play a major role in plant distribution patterns in many of the middle and northern Rockies east of the Continental Divide, including the Big Horns. A series of vegetation studies has been completed in the Big Horns (Hurd, 1961; Despain, 1973; Hoffman & Alexander, 1977).

Big Horn Mountain *Pinus contorta* forests occupy sites overlying the coarse and nutrient-poor granitic soils. Grasslands and shrublands generally occupy soils from shale and limestone, except where forests are supported in areas where moisture stress is lessened due to slope aspect (Arno & Hammerly, 1984). *Picea engelmannii* and *Abies lasiocarpa* occur in the subalpine-timberline zone of the Big Horn Range, but *Pinus albicaulis* is absent from this area. *Pinus contorta* is dominant on granitic soils at elevations below the subalpine zone which extends from 2,700 m to 2,100 m. The lower timberline is formed by *Pseudotsuga menziesii* near 1,800 m. Juniper woodlands (*Juniperus scopulorum* and *J. osteosperma*) are closely associated with the *Pseudotsuga menziesii* zone on the west slopes; *Pinus edulis* is replaced by *Pinus flexilis* in this juniper community type. *Pinus ponderosa* var. *scopulorum* becomes important only in this part of the middle Rocky Mountains (east face of Wyoming Big Horns and northward into Montana) but does not display the large growth forms seen among the *P. ponderosa* var. *ponderosa* occurring further west. Geographically, *P. ponderosa* var. *scopulorum* occurs eastward into the Black Hills of South Dakota, to the exclusion of Rocky Mountain conifers (Johnson & Pfister, 1982).

The middle Rockies support widespread sagebrush-grass; Tisdale & Hironaka (1981), Blaisdell et al. (1982), Hironaka et al. (1983), and West (1983) provided in-depth literature reviews of the major community types in the nonforested areas of this region. Where the Wyoming Basin and Great Plains meet, there exist sod-forming grasslands dominated by *Bouteloua gracilis* and *Agropyron smithii* intermixed with *Artemisia tridentata* and other sagebrush taxa. These communities are the products of the continental climate, with growth moisture arriving in early summer rainfall. Elsewhere in southern and central Idaho and southwestern Montana, bunchgrass prairies are present, dominated by *Agropyron spicatum, Festuca idahoensis, Stipa comata,* and *Poa sandbergii.* In these sagebrush-bunchgrass communities, moisture comes primarily in winter and spring, with droughty summers.

The middle Rockies sagebrush-bunchgrass community types recognized by Hurd (1961), Beetle & Johnson (1982), Johnson & Pfister (1982), and Hironaka et al. (1983) include the following, each named after the major dominant: a) *Festuca idahoensis,* b) *Agropyron spicatum,* c) *Bouteloua gracilis,* d) *Purshia tridentata,* e) *Symphoricarpos oreophilus,* f) *Artemisia tridentata,* g) *A. tripartita,* h) *A. nova,* i) *A. arbuscula,* j) *A. longiloba,* k) *A. cana,* l) *A. rigida,* m) *Atriplex canescens/A. confertifolia/A. nuttallii,* and n) *Sarcobatus vermiculatus.* Shrubland community types in the same region include a) *Quercus gambelii,* b) *Acer grandidentatum,* and c) *Cercocarpus ledifolius.*

Modern (post-1900) vegetation shifts in middle Rocky Mountain ecosystems, believed to be induced by fire suppression and domestic grazing (Sauer, 1950; Humphrey, 1962; Steele et al., 1981, 1983), also involve extensive invasion by *Juniperus occidentalis* into grassland and sagebrush communities. Tisdale & Hironaka (1981), pointing to the sensitivity of *Artemisia* to fire, suggested that fires in presettlement times must have been infrequent (long interval) in some parts of the sagebrush region, such as drier *Artemisia* habitat types where fuel loads were low.

The *Juniperus* woodland expansion in the Rocky Mountains and adjacent regions was described by Barney & Frischnecht (1974) and Young & Evans (1981). Problems attending these changes were described in a lengthy juniper management symposium (Martin et al., 1978). Through wood rat (*Neotoma*) midden and lake sediment analysis, Mehringer & Wigand (1986) documented that western juniper has had a long history of rapid geographic shifts in response to climate changes during the past 4,000 years. They stated, ". . . the spectacular and persistent expansion of western juniper over the last hundred years—despite chaining, bulldozing, cutting, poisoning and burning—is not an unusual event necessarily requiring explanations unique to the historic period. In fact, the rate and degree of change in the comings and goings of western juniper over the late Holocene are equal to or greater than those seen over the past hundred years" (Mehringer & Wigand, 1986: 118).

Plant communities historically used as sheep and cattle range throughout the middle Rockies have been severely altered as a result of abusive levels of grazing. Employing paired-stand analysis techniques, range ecologists have provided extensive documentation of compositional changes attributed to grazing. Native species of

FIGURE 19. *Abies lasiocarpa* (center) and *Pinus flexilis* (left & right) on King's Hill (2,200 m) in northern continental ranges, central Montana; Lewis and Clark National Forest, Montana. USDA Forest Service.

Agropyron, Festuca, Poa, and *Stipa* are classed as "decreasers" which are reduced in abundance. In their place, introduced grasses and forbs invaded and, for all practical purposes, have created new vegetational equilibria on the western rangelands. As an example, cheatgrass (*Bromus tectorum*), an introduced annual grass, has proven to be a superior competitor in western bunchgrass communities (Harris, 1967; Mueggler & Harris, 1969; Daubenmire, 1970; Mueggler & Stewart, 1980) and has come to dominate large areas in the middle and northern Rockies.

Other invaders that have become widespread on rangelands include *Poa pratensis, Centaurea maculosa, Cirsium vulgare, Tragopogon dubius, Euphorbia esula,* and *Hypericum perforatum.* Many of these species, along with *Rudbeckia occidentalis,* have also become established in conifer forests severely disturbed by logging and/or domestic grazing. Man's present-day penchant for working land on higher and steeper slopes is contributing to an acceleration of vegetation change. Furthermore, conflicts between agriculture and livestock, and winter foraging by big game, frustrate efforts to reverse the loss of native plant components.

OTHER ROCKY MOUNTAIN VEGETATION TYPES

Other vegetation types occurring within the northern Rockies are described below. Some of these are distributed throughout the northern Rocky Mountains, i.e., timberline/alpine tundra and wetland/riparian types, while others are confined to single mountain ranges or unique localized habitats.

TIMBERLINE AND ALPINE TUNDRA

Upper treeline reaches 2,275 m in southern Alberta and nearly 3,650 m in southern Colorado. Treeline zones in the interior continental mountains are subject to cold polar air and high winds (Fig. 19). Dry powdery snow accumulates at moderate to great depths but melts away during summer. Sharp temperature fluctuations also create severe winter stresses. In contrast, inland maritime timberline/alpine tundra is more moist

FIGURE 20. Alpine and nival life zones in vicinity of Beartooth Pass (3,300 m), Custer National Forest, Montana. USDA Forest Service.

than the continental areas and experiences less extreme winter temperatures.

Common northern Rocky Mountain timberline tree species have been identified earlier; these intermix islandlike within the lower alpine tundra zone. Slope aspect, microtopography, patterned ground (resulting from cryopedogenesis), soil chemistry, soil water potential, and wind exposure combine to form an environmental complex (Fig. 20) that dictates the arrays of low shrubs, perennial herbs, and graminoids forming the northern Rockies timberline/tundra ecosystems (Griggs, 1938; Choate & Habeck, 1967; Bamberg & Major, 1968; Habeck, 1969; Billings, 1969, 1978; Smith, 1969; Johnson & Billings, 1962; Arno & Hammerly, 1984; Bliss, 1985; Spence, 1985; Peet, 1987).

Alpine permafrost occurs in some northern Rocky Mountain ranges, where mean annual air temperature is at or below 0°C and may, according to Pewe (1983), date back to Wisconsin time when such frozen soil was widespread 1,000 m below present-day elevations. Such permafrost areas coincide with modern treeless areas where alpine vegetation may favor maintenance of the frozen soil conditions. Vegetation dynamics on sites that have experienced recent ice retreat have been described in detail by Spence (1985) for parts of Wyoming's Teton Range. He investigated plant invasions on moraines fronting glaciers. Continual disturbances take place on the moraines, and compositional differences among his study areas do not seem closely related to a successional chronosequence.

Bliss (1985) reviewed the physiological ecology of alpine and timberline plant communities in North America, adding to earlier efforts that emphasized floristic phytogeography. He stated that complexities of community structure and composition in the alpine zone, including spatial discontinuities between mountain ranges, have permitted only generalized classification units. Growth and survival in the alpine are closely related to growth forms. Bliss (1985) listed and